

Space Weather Technical Forecast

Issued on Saturday, 01 April 2023 at 00:31 Local

This technical forecast provides a four day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales <https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales>

Space Weather Forecast Headline: Chance of both Minor Radio Blackouts and Minor Geomagnetic Storms easing today. Active electron fluence becoming Likely into UTC weekend.

Analysis of Space Weather Activity over past 24 hours

Solar Activity: Solar activity has been Low over the past 24 hours, with generally only occasional small C-class flares recorded at GOES16 and 18. The peak flare of the period was a C9.8 however, at 31/2057UTC, which looks to have originated over the southwestern limb, perhaps aided by a fairly simultaneous flare by the relatively unassuming AR3262 on the southwest of the disc. No Earth directed Coronal Mass Ejections (CMEs) have been detected in available coronagraph imagery.

There are currently four numbered sunspot regions remaining on the disc. One unnumbered region developed as a Bxo to the immediate west of AR3264, but has since faded to an Axx with another small unnumbered region in the southeast disk showing slight development as a Bxo. All other groups were stable or in slight decay.

Solar Wind / Geomagnetic Activity: The solar wind, as measured at L1 by ACE and DSCOVR, was characterised by the fast wind associated with CH88/- to start the period with solar wind speeds elevated to strong at around 600-650km/s, with a peak speed of approximately 690km/s recorded around 31/0350 UTC. From around 31/1100 UTC solar winds have decreased to Slightly elevated levels around 460-480km/s as the HSS stream associated with CH88 looks to be waning. The phi angle was accordingly negative (towards the Sun) to start but has become increasingly variable with the move into slower winds. The solar wind density has been below average throughout, but increased slightly from around 31/1100 UTC, becoming more stable. The IMF showed an erratic falling tendency from a peak around 9nT early in the period. The north-south component ranged between +4 and -7nT, but was mostly anti-aligned with Earth's field to greater geomagnetic effect.

The result of the above solar wind measures was for Quiet to Active geomagnetic conditions.

Energetic Particles / Solar Radiation: High energy proton enhancement (greater than 10MeV) has been at background levels.

The high energy electron flux (greater than 2MeV), as measured at GOES16 showed a greatly attenuated diurnal oscillation to start the period, with a range between Moderate and Normal Background, but with a rising trend from around 31/1100 UTC, with the peak flux was 1230pfu at 31/2050UTC. The associated 24-hour fluence has been below the Active ($1e8$ integrated pfu) threshold throughout, recording $3.12e7$ integrated pfu at 01/0001UTC.

Four-Day Space Weather Forecast Summary

Solar Activity: An initial Chance of further M-class flares as Ex-AR3256 continues to rotate

Issued by Met Office Space Weather Advisor, Tel: +44 (0) 330 135 4254 Email: moswoc@metoffice.gov.uk

away around the southwest limb. The risk of further such events should then sharply decline with generally Low solar activity expected, with an uncertain degree of compensation possible from arriving east limb regions, particularly later into the period. These regions will be assessed as and when they present for analysis.

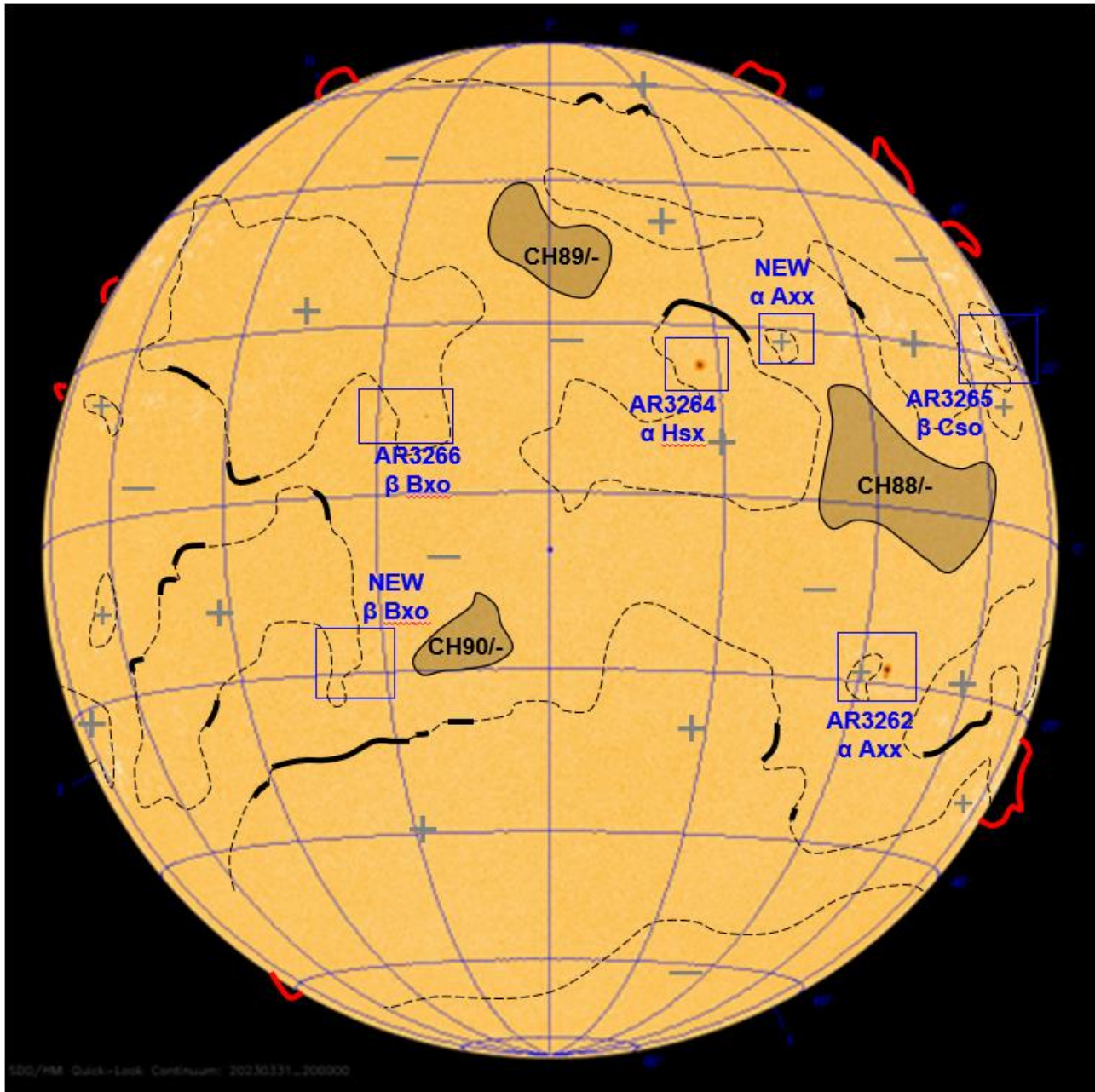
Solar Wind / Geomagnetic Activity: A re-analysis of a portion of the 29 March prominence eruption from the southeastern limb now presents a Slight Chance of glancing incidence later in Day 2 (2nd), although the deterministic MOSWOC Enlil run has a miss. This is the only CME to feature in the forecast at present.

The Earth looks to be exiting the fast wind associated with CH88/-, with solar wind speeds waning. This feature continues to have an effect however with a risk of Active and Minor Geomagnetic Storm G1 conditions persisting into Day 1. Largely Quiet conditions should establish through Day 2, although there remains a Slight Chance of G1 should the 29 April CME glance Earth possibly later in the day. Later Day 3 and into Day 4 Earth will likely begin to see the effect of approaching coronal holes, these bringing a Chance of Minor Geomagnetic Storm G1 conditions once again.

Energetic Particles / Solar Radiation: High energy (greater than 10MeV) proton flux maintain a Slight Chance of breaching S1 given the history of Ex-AR3256 as it continues to rotate away around the southwest limb through Day 1, thereafter risk returning towards background into the forecast period pending any further developments.

The high energy (greater than 2 MeV) electron flux is expected to recover to breach Active 24-hour fluence levels into the UTC weekend and perhaps the new week, should the potential CME glance not materialise, before a further suppression expected by Day 4 in association with approaching coronal high speed winds.

Figure 1. Solar Analysis Valid 31/2000 UTC.



Key: Filament ---, Prominence ---, Magnetic Field Line - - -, Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-γ-δ and Zurich-McIntosh Axx etc.

Geomagnetic Storms:

A re-analysis of a portion of the 29 March prominence eruption from the southeastern limb now presents a Slight Chance of glancing incidence later in Day 2 (2nd), although the deterministic MOSWOC Enlil run has a miss. This is the only CME to feature in the forecast at present.

The Earth looks to be exiting the fast wind associated with CH88/-, with solar wind speeds waning. This feature continues to have an effect however with a predominantly anti-aligned Bz component with Earth's field seeing a risk of Active and Minor Geomagnetic Storm G1 conditions persisting into Day 1. Largely Quiet conditions should establish through Day 2, although there remains a Slight Chance of G1 should the 29 April CME glance Earth possibly later in the day. Later Day 3 and into Day 4 Earth will likely begin to see the effect of approaching coronal holes 89 and 90, with CH90 in the southern hemisphere expected to be the dominate feature. This bringing a Chance of Minor Geomagnetic Storm G1 conditions once again.

Geo-Magnetic Storm	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability (Exceedance)			(%)	(%)	(%)	(%)
Minor or Moderate	G1 to G2	No	30	10	20	30
Strong	G3	No	1	1	1	1
Severe	G4	No	1	1	1	1
Extreme	G5	No	1	1	1	1

Geomagnetic Activity - Earthbound Coronal Mass Ejections

Date/time 21.5R (UTC)	Halo: Full or Partial	Source	Source Location	Estimated Speed	Estimated Arrival Time	Comments
30/1013	Partial	Prominence	SE Limb	231 km/s	02/2100 UTC	Glancing blow, most likely miss.

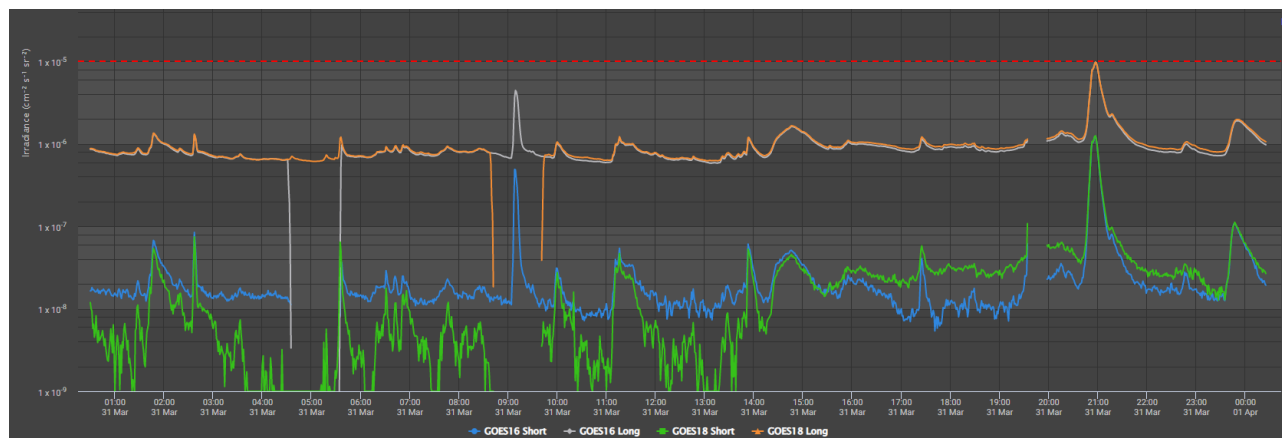
Radio Blackouts - X-Ray Flares:

The four-day forecast period should see a fairly large reduction in flare risk within day one as the recent large sunspot group AR3256 further rotates away from the Earth-facing disk, such that only relatively few, simple regions remain.

Meanwhile, in the east, multiple returning regions signaled to potentially arrive during the period, although for now there are no major signs of increased activity from STEREO A EUVI imagery or flux looping from beyond the limb. Soundings suggest the most active of these region most likely into Day 4, but these regions will be assessed as and when they present for analysis.

X Ray Flares	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability			(%)	(%)	(%)	(%)
Active	R1-R2 M Class	No	10	5	5	10
Very Active	R3 to R5 X Class	No	1	1	1	1

Figure 2: Last 24hr X-Ray trace.



Solar Radiation Storms - (High Energy Protons):

While no recent S1-level enhancements have been recorded, we maintain a Slight Chance of breaching S1 given the history of Ex-AR3256 as it continues to rotate away around the southwest limb through Day 1, thereafter risk returning towards background into the forecast period pending any further developments.

Radiation Storms	Level ($\text{cm}^{-2}\text{sr}^{-1}\text{s}^{-1}$)	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability (Exceedance)			(%)	(%)	(%)	(%)
Active	$\geq \text{S1}$	No	5	1	1	1
Very Active	$\geq \text{S3}$ *	No	1	1	1	1
* S3 $\geq 10 \text{ MeV} \geq 1000 \text{ pfu}$ and / or $\geq 50 \text{ MeV} \geq 10 \text{ pfu}$. (pfu = $\text{cm}^{-2}\text{sr}^{-1}\text{s}^{-1}$)						

High Energy Electrons Event ($\geq 2\text{MeV}$):

The flux at GEO has been significantly attenuated by geomagnetic activity from the coronal hole fast wind associated with CH88 in the past 24 hours, but flux levels are increasing as solar wind speeds have declined in recent hours with fluence levels beginning to rise in response.

MOSWOC REFM is perhaps a little muted in its expected response, with something more similar to persistence preferred, whereby fluence levels should exceed Active levels into the UTC weekend. There is a slight question mark as to the presence and effect of any glancing blow from a CME later Day 2 into Day 3, although the most likely course of events is that this CME will miss to no effect of electrons at GEO. The presence of any CIR associated approaching coronal holes also adds to the complication into Day 3 before we should see fluence levels decrease into Day 4 as we look to move into coronal hole fast winds, most likely associated with CH90.

GEO Electron Environment	Level ($\text{cm}^{-2} \text{sr}^{-1} \text{day}^{-1}$)	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability (Exceedance)			(%)	(%)	(%)	(%)
Active	$\geq 2 \text{ MeV}$ $\geq 1 \times 10^8$	No	30	70	60	30
Very Active	$\geq 2 \text{ MeV}$ $\geq 1 \times 10^9$	No	1	5	5	1

Figure 3: Latest MOSWOC REFM Model output.

